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SUGAR BEETS
ECONOMICS OF MACHINERY INVESTMENT

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and
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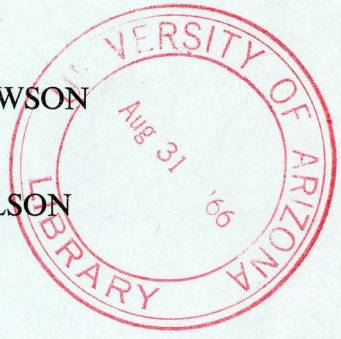

Arizona Agricultural Experiment Station
The University of Arizona

in cooperation with

Farm Production Economics Division
Economic Research Service
U.S. Department of Agriculture

Contents

SUGAR BEETS:

ECONOMICS OF MACHINERY INVESTMENT

by

Walter W. Pawson[1] and Aaron G. Nelson[2]

Summary

To produce sugar beets requires special machinery and equipment which most Arizona farmers do not have. To purchase the special preharvest equipment that is needed to plant, mechanically thin and cultivate beets requires an investment of $2,350 and $6,300, depending on the size, make, and model of equipment.

The larger the acreage on which this machinery is used, the lower are the machinery costs per acre. The costs per acre for planting, mechanically thinning, cultivating and side dressing beets are estimated to decline from $29.00 when this equipment is used on 20 acres of beets to $9.50 when it is used on 240 acres of beets.

Farmers who have a small acreage of beets may find it less expensive to hire a custom operator to do these jobs than to own the equipment. With 70 or more acres of beets, the purchase of 4-bed equipment is the most economical over a period of years. However, farmers who do not have experience in sugar beet production and who are uncertain whether they will continue to grow beets indefinitely may find it desirable to hire a custom operator to do these jobs for a time.

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A 4-bed planting, thinning and cultivating outfit can take care of as much as 240 acres of beets. A substantial reduction in machinery investment per farm and in the annual costs per acre for the use of this equipment can be achieved by a group of farmers participating in the joint ownership of this equipment.

A farmer may find it profitable to purchase 4-bed equipment and do custom work for other sugar beet growers in addition to using the equipment for his own beets.

The precision planters and precision cultivators that are needed for sugar beet production can be used for cotton and other crops.

A beet harvester and the tractor to operate it involve an investment of $13,000 to $18,000. It will not pay individual farmers to own a harvester. They can either hire the job done by custom operators or participate with other farmers in the joint ownership and operation of harvesting machinery. It is estimated that through the joint ownership and efficient operation of harvesting machinery, it would cost as little as one-half as much to harvest beets as it would to hire a custom operator to do the work.

Purpose of This Report

Arizona farmers will start growing sugar beets in the fall of 1966. To produce sugar beets requires certain items of machinery and equipment that most farmers do not have. The purpose of this report is to provide information concerning the cost of the special machinery and equipment needed for sugar beet production and the size of equipment to buy for a given size operation. Factors to consider in deciding whether to buy equipment for one's own use, to hire the work done by a custom operator, or to engage in doing custom work for others are discussed. The saving that can be achieved through the joint ownership with other farmers of the machinery and equipment needed for sugar beet production is also considered. This report also provides information on estimated rates of performance and the costs of operating the equipment.

Special Preharvest Machinery

Machinery Investment Requirements

Most farmers own or have access to the ordinary kinds of equipment to prepare a seedbed for sugar beets. These include a plow, chisel, disk, float or landplane, and lister. However, to produce sugar beets without the use of scarce, expensive hand labor for thinning and weeding requires the use of bed shapers, precision planters, precision cultivators, and mechanical blockers (generally referred to as mechanical thinners). These items can be mounted on a multipurpose sled tool carrier, thus saving the cost of buying separate units for planting, cultivating, and thinning.

Most Arizona farmers do not have this equipment. To purchase these items will require an investment of $2,350 to $6,300, depending upon the size, make, and model of the units that are bought. Small size equipment that will cover 2 double-row beds will cost about $2,350 to $3,650 (Table 1). Equipment that will handle 4 double-row beds simultaneously will cost about $4,600 to $6,300 (Table 1).

Table 1. Investment required for special preharvest machinery needed for sugar beet production at 1966 prices.

Item	2 Double-bed Equipment	4 Double-bed Equipment
	Dollars	Dollars
Multipurpose sled tool carrier:		
With 3-point hitch	625--1,050	a
Pull type with hydraulic lift	1,000--1,400	1,150--1,800
Attachments:		
Bed shapers and precision planters	800--1,000	1,600--2,000
Cultivating attachments	200-- 250	400-- 500
Mechanical blockers	725--1,000	1,450--2,000
Total	[b] 2,350--3,650	4,600--6,300

[a] A 3-point hitch is not well adapted to 4 double-bed equipment.

[b] The minimum investment is based on a sled tool carrier with a 3-point hitch. The maximum investment assumes a pull-type sled tool carrier with hydraulic lift.

Other items of preharvest equipment that a farmer may find useful, or perhaps necessary, for growing sugar beets include a rolling cultivator or power mulcher for preparing the seedbed, and a roller and a mechanical tine weeder-thinner for thinning and weeding. Data concerning the costs of purchasing or operating these kinds of equipment are not included in this report. For further information about machinery, see Sugar Beets: Mechanization, by Marshall M. Machado, Folder 115, Cooperative Extension Service, The University of Arizona.

Should you buy the special equipment that is needed to produce sugar beets, or should you hire a custom operator to do the work? What size of equipment should you buy? Would you profit by joint ownership of equipment with other farmers?

The answers to these questions depend on the following factors:

(1) The acreage of sugar beets that you will grow,

(2) Whether you will continue to grow beets indefinitely in the future,

(3) Whether you will use this equipment for producing other crops as well as sugar beets,

(4) The rates charged for and availability of custom work, and

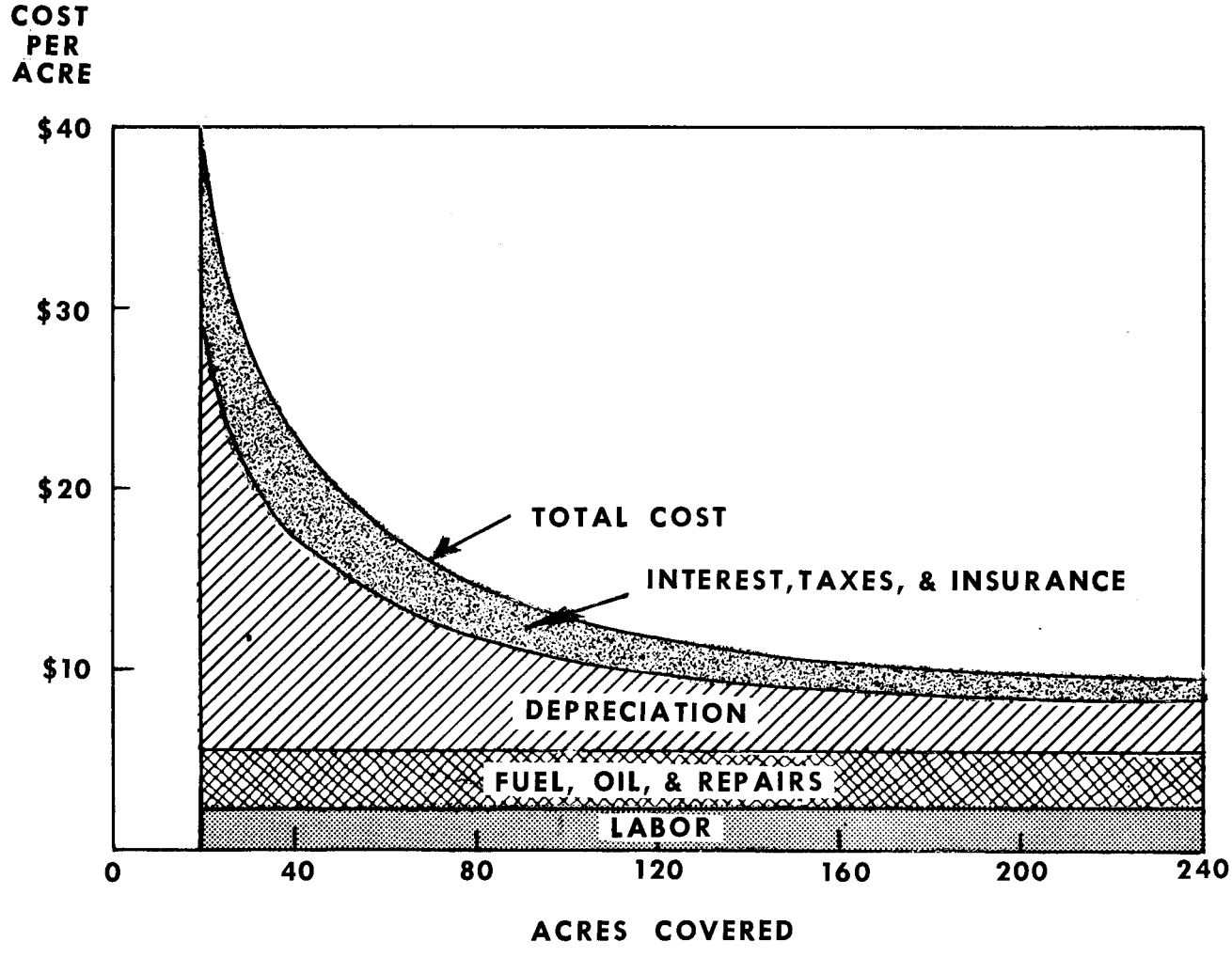
(5) Your willingness to accept the inconvenience and problems that may be associated with joint ownership of equipment with other farmers in order to save money.

Machinery Costs Per Acre in Relation to Acreage Covered, Size of Equipment, and Custom Rates

The larger the acreage of beets which is planted, cultivated and thinned with a given sled tool carrier and its attachments, the lower are the costs per acre for the use of this special preharvest machinery. Figure 1 shows how the various items of cost for planting, cultivating and mechanically thinning sugar beets vary in relation to the acreage of beets on which the machinery is used. This illustration applies to 4 double-bed equipment. The cost for labor, fuel and oil, and repairs and maintenance

Figure 1

Estimated Cost Per Acre for Planting, Thinning,
Cultivating and Side Dressing Sugar Beets
With 4-Bed Equipment
As Affected by Acreage Covered



on tractor and equipment is a constant amount per acre, regardless of how many acres the equipment is used on. The cost per acre for depreciation, interest, insurance and taxes on the equipment varies almost inversely in proportion to the acreage covered. Total costs per acre decline sharply as the acreage on which the equipment is used increases. If this special equipment is used on only a small acreage, the costs per acre are very high. When the equipment is used on a large acreage, the costs per acre are much lower.

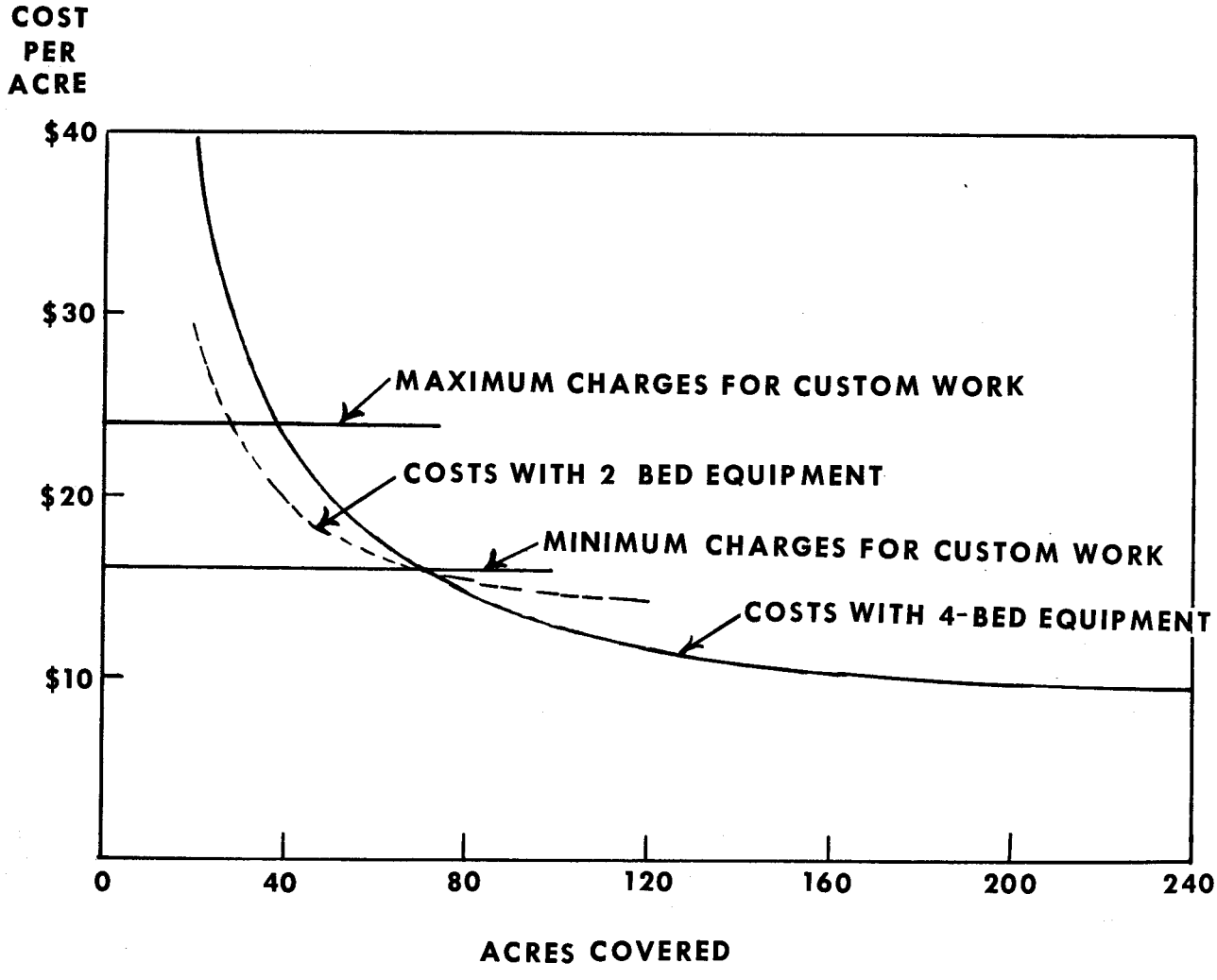
A farmer can plant, cultivate, side dress and thin his beets by: (1) buying 4-bed equipment, (2) buying 2-bed equipment, or (3) hiring a custom operator to do the work. Figure 2 shows the cost per acre for performing these jobs in these three ways on various acreages of beets.

On small acreages, it may cost less to hire a custom operator to perform the work than for the grower to purchase and use his own equipment. The minimum acreage of beets, at which it would be less expensive for a farmer to buy equipment than to hire a custom operator to do the work, is estimated to range from 30 to 70 acres per farm, depending on the rates charged for custom work. If a farmer could have his beets planted, mechanically thinned, cultivated and side dressed for $16 per acre--which is estimated to be the minimum probable charge for custom work over the long run--farmers who grow less than 70 acres of beets would find it less expensive to hire a custom operator to do these jobs than to purchase their own equipment (Figure 2). On the other hand, if the custom rates for this work are as much as $24 per acre, farmers who grow 30 acres or more of beets would find it less expensive in the long run to purchase their own equipment than to hire it done by a custom operator.

If preharvest equipment is purchased for growing less than 70 acres of beets, 2-bed equipment will entail lower costs per acre than 4-bed equipment (Figure 2). If the equipment is to be used on more than approximately 70 acres of beets, 4-bed equipment will be more economical in the long run than smaller size equipment (Figure 2).

Figure 2

Estimated Cost Per Acre for Planting, Thinning,
Cultivating and Side Dressing Sugar Beets
As Affected by Size of Equipment,
Acreage Covered, and Ownership of Machinery



A breakdown of costs by categories for specified operations, using 2-bed and 4-bed equipment, respectively, on various acreages is given in Table 2. This table also provides a comparison between the cost of performing these operations with one's own equipment or of hiring the work done by a custom operator.

The costs per acre as given in this report reflect the long run costs over a period of years. The annual costs are based on the assumption that the equipment will continue to be used over its full life. It is estimated that sled tool carriers, precision planters and mechanical thinners will last for a maximum of about 12 years.

Farmers who are uncertain whether they will continue to grow beets indefinitely may find it desirable to hire a custom operator to do these jobs during the initial trial period of sugar beet production. This may temporarily cost more per acre than it would cost over the long run if equipment were purchased. However, in this way the possible loss of a large investment in sugar beet production equipment could be avoided. Also, farmers may find it advantageous to hire an experienced custom operator to do these special jobs for them until they themselves gain experience in sugar beet production. However, if custom operators are not available who can perform the operations on a reasonably timely basis, it may be necessary to purchase machinery to get the work done on time.

Rates of Performance and Capacity of Preharvest Equipment

The estimated range in rates of speed at which sugar beet planters, cultivators and mechanical thinners will likely be operated is shown below. The acreage covered per day with 2-bed and 4-bed equipment is estimated as follows:

Operation	Speed (m.p.h.)	Acres covered per 10-hour day	
		Using 2-bed equipment	Using 4-bed equipment
Shape beds and plant	2 - 2-1/2	13 - 16	26 - 32
Cultivate, first time	3 - 4	19 - 25	37 - 50
Later cultivations	4 - 6	26 - 39	52 - 78
Cultivate and fertilize	4 - 6	21 - 31	42 - 63
Mechanical blocking	3 - 4	17 - 23	35 - 46

Table 2. Estimated costs of performing specified preharvest operations with different sizes of equipment on different acreages, and estimated charges per acre for custom work

Item	Estimated cost per acre						Estimated charges per acre for custom work
	Labor	Fuel & oil	Repairs & maintenance	Depreciation a/	Interest, taxes, & insurance	Total costs	
Shape beds & plant (2 men)	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.
With 2-bed equipment							
Used on 20 acres	1.80	.25	.81	3.87	1.85	8.58	)
Used on 40 acres	1.80	.25	.81	2.01	.98	5.85	)
Used on 80 acres	1.80	.25	.81	1.09	.54	4.49	) 4.00
With 4-bed equipment							) to
Used on 80 acres	.93	.16	.62	1.93	.95	4.59	) 6.00
Used on 160 acres	.93	.16	.62	1.01	.50	3.22	)
Used on 240 acres	.93	.16	.62	.78	.35	2.84	)
Cultivate and side dress b/							
With 2-bed equipment							
Used on 20 acres	.59	.19	.50	1.39	.67	3.34	)
Used on 40 acres	.59	.19	.50	.74	.36	2.38	)
Used on 80 acres	.59	.19	.50	.43	.21	1.92	) 2.00
With 4-bed equipment							) to
Used on 80 acres	.29	.12	.36	.55	.26	1.58	) 3.00
Used on 160 acres	.29	.12	.36	.31	.14	1.22	)
Used on 240 acres	.29	.12	.36	.31	.11	1.19	)
Mechanical thinning							
With 2-bed equipment							
Used on 20 acres	.68	.23	.64	3.73	1.78	7.06	)
Used on 40 acres	.68	.23	.64	1.93	.93	4.41	)
Used on 80 acres	.68	.23	.64	1.03	.50	3.08	) 4.00
With 4-bed equipment							) to
Used on 80 acres	.32	.14	.46	1.86	.88	3.66	) 6.00
Used on 160 acres	.32	.14	.46	.95	.39	2.26	)
Used on 240 acres	.32	.14	.46	.66	.32	1.90	)
Total, above operations c/							
With 2-bed equipment							
Used on 20 acres	4.84	1.22	3.45	13.16	6.31	28.98	)
Used on 40 acres	4.84	1.22	3.45	6.90	3.35	19.76	)
Used on 80 acres	4.84	1.22	3.45	3.84	1.88	15.23	)16.00
With 4-bed equipment							) to
Used on 80 acres	2.42	.78	2.50	5.99	2.88	14.57	)24.00
Used on 160 acres	2.42	.78	2.50	3.20	1.45	10.35	)
Used on 240 acres	2.42	.78	2.50	2.68	1.10	9.48	)

a/Depreciation charges are based on the following estimated maximum years of life or maximum hours of use to wear out, whichever occurs first:

Type of Equipment	Maximum Years of Life	Maximum Hours of Use to Wear Out
Sled tool carrier	12	2,500
Bed shapers	8	500
Precision planters	15	1,200
Mechanical blockers	12	1,200
Wheel tractor	--	12,000

b/Represents average of four cultivations, including side dressing. Entire cost of sled tool carrier is charged to cultivating and side dressing.

c/Represents total of six operations, as follows: bed shaping and planting; four cultivations, including side dressing; and mechanical thinning.

With 4-bed equipment it should be possible to take care of as many as 240 acres of sugar beets, and with 2-bed equipment, 120 acres. Planting could be done in 8 to 10 days with this equipment. Thinning and cultivation operations would take less time.

Joint Ownership of Equipment with Other Farmers

Farmers may well consider owning jointly with neighboring farmers the special equipment that is needed to grow sugar beets. By this means, the machinery investment per acre can be cut. The cost per acre for depreciation, interest, taxes and insurance on this equipment can be reduced.

It is estimated that a 4-bed outfit shared by several growers can plant, cultivate, side dress and thin as many as 240 acres of beets, provided all the growers do not want to plant on the same day.

If three farmers each having 80 acres of beets were to jointly purchase a 4-bed line of equipment, the required investment would be only about $1,500 to $2,100 per farm. Total annual costs as low as $9.50 per acre for planting, cultivating and mechanical thinning of sugar beets could be achieved (Table 2).

Doing Custom Work

A farmer may find it advantageous to purchase 4-bed equipment and do custom work for other sugar beet growers in addition to using the equipment for his own beets. In this way, he could achieve the relatively low costs per acre that are realized with a large acreage. It appears that custom work would be a profitable venture, even at the minimum probable custom rates. However, a number of factors need to be considered. First, a farmer needs to have the experience and ability to do the quality of work demanded of a custom operator. Second, doing custom work may compete with the farmer's own crops for tractor power, operating capital, labor, and management. The competition will be greatest during the cotton harvesting season since most of the

preharvest customs operations on sugar beets must be done during that period. Third, if many farmers do custom work, the anticipated profits may not be realized.

Use of Sugar Beet Equipment for Other Crops

Farmers who contemplate the purchase of special equipment for precision planting, precision cultivation and mechanical thinning of sugar beets may want to consider buying 4-bed equipment and using it on cotton and other row crops which they grow.

With a precision planter, cotton can be planted to a stand, thus saving the cost of hand labor for chopping cotton. (See Planting Cotton to a Stand, by W. E. Larson and M. D. Cannon, Bulletin A-46, The University of Arizona Cooperative Extension Service and Agricultural Experiment Station.)

More acres can be cultivated per day with a precision cultivator than with an ordinary cultivator. A precision cultivator not only cultivates close to the plants, but it can be driven at a much faster rate of speed than an ordinary tractor-mounted cultivator. It also takes less skill to drive a sled-mounted precision cultivator than an ordinary tractor-mounted cultivator.

The bed shapers and planters that are required for sugar beet production are ideal for planting sorghum, safflower and vegetables in double-row beds. Higher yields of sorghum and safflower can be obtained by planting in double rows than in single rows.

Harvesting Machinery

Individual farmers in Arizona cannot grow more than 160 acres of beets, according to present Government regulations. Under these circumstances, it does not appear practical for individual farmers to purchase their own beet harvesting machinery. Harvesting machinery is high priced. Small, one-row harvesters do not operate well in double-row beets. An individual farmer who owned his own harvester would have to harvest beets just a few hours per day virtually every day that the sugar factory operates in order to meet his daily factory delivery quota.

There are two practical ways in which farmers can arrange to harvest their beets: (1) hire the job done by custom operators, or (2) participate with other farmers in the joint ownership of a beet harvester.

Charges for Custom Harvesting

Custom harvesters in other beet growing areas have shown a strong interest in contracting to harvest the Arizona crop. It is estimated that the charges for custom harvesting in 1967 will run about $1.25 to $1.35 per ton plus an additional 10¢ to 15¢ per ton if the tops are windrowed. These charges apply to the gross tonnage of beets harvested, which includes a tare of about 4.5 percent.

Machinery Investment Requirements

A 2-row beet harvester costs from $6,500 to $9,000 depending on the make and model. These machines require a 70 to 85 h. p. tractor with a "live" power take-off to pull them. A new tractor of adequate size costs approximately as much as the beet harvester. The total investment in harvesting machinery, therefore, would amount to about $13,000 to $18,000.

This assumes that a beet harvester with topper attachment is purchased. If the tops are cut and windrowed separately, before the beets are harvested, an investment of up to $5,000 for the purchase of a beet topper-windrower will also be required; in addition, a medium-size tractor would be needed to operate it.

One-row beet harvesters are less expensive than two-row harvesters, but they are not well adapted to harvesting double-row beets.

Rates of Performance, Capacity of Beet Harvester, and Operation of Harvest Pools

Modern beet harvesters with a tractor of adequate size can harvest beets at a speed of 3 to 5 miles per hour. At a speed of 4 miles per hour, a 2-row machine will harvest about 0.9 to 1.1 acres of double-row beets per hour. This allows for "down" time for making repairs and adjustments in the field, traveling from one farm to another, etc.

A modern 2-row harvester with an adequate size tractor can readily harvest 700 acres of beets during the harvest season, which will likely extend from about April 20 to July 31.

A uniform aggregate tonnage of beets must be delivered to the sugar factory each day during the harvest season. In California, harvesting is accomplished by forming "harvest pools." Each "harvest pool" consists of a group of farmers who have access to a beet harvester and trucks. The beet harvester may be owned either by a custom operator or by a group of sugar beet growers. Each "harvest pool" operates full time during the harvest season, except that they usually have 1 day off each 7 days. The days off are staggered among the various "harvest pools" so that a uniform tonnage of beets is delivered to the factory each day.

The farmers in each "harvest pool" draw lots and take turns as to the sequence in which their beets are harvested. The beet harvester moves from farm to farm at intervals. Several passes are made through each farmer's field during the season. On any given farm, beets are harvested only at periodic intervals.

Each "harvest pool," as a group, must deliver to the sugar factory a specified tonnage of beets every day that the beet harvester operates. For a 700-acre "harvest pool" in Arizona, the daily quota is estimated to be approximately 170 tons per day. On the average, about 8-1/2 acres of beets would be harvested per day. However, at the beginning of the season, when yields are low, it is estimated that about 13 acres of beets would have to be harvested per day to meet the factory delivery quota. Toward the end of the season, when yields are high, only about 6 or 7 acres might need to be harvested per day to fulfill the quota. This necessitates a long work day at the beginning of the harvest season. Toward the end of the harvest season, with fewer acres to harvest per day, most harvest crews finish their work early in the afternoon.

Potential Savings from Joint Ownership of Harvesting Machinery

Suppose that a group of farmers in a community who have contracts for growing a total of about 700 acres of beets are considering jointly purchasing and operating a beet harvester to harvest their beets.

It would require an investment of about $19 to $26 per acre of beets to purchase the machinery, including a 2-row beet harvester with topper attachment and a new tractor of adequate size to pull the harvester.

Table 3 shows the estimated annual cost of the harvesting operation. For this purpose, it is assumed that an $8,000 harvester and an $8,000 tractor are purchased. The beet harvester could be expected to last only 3 years when used to harvest 700 acres of beets each year, according to information from California growers and dealers. Expenses for repairs on the beet harvester, including a complete annual overhaul, are estimated to average about $1,600 per year. The total annual cost for the tractor is estimated at about $2,200 (Table 3). Beet harvesting is a one-man operation. However, in addition to a full-time tractor driver, someone would need to be in charge of the harvesting operation. For example, one of the cooperating farmers might take this responsibility on a part-time basis. The total annual cost of harvesting 700 acres of beets is estimated at $9,580 (Table 3). Assuming a yield of 20 tons of beets per acre, the total cost of harvesting is estimated at about 65 cents per ton, including tare (Table 3).

In comparison with charges of $1.25 to $1.35 per ton for custom harvesting, it is estimated that, over the long run, growers could save about 60 to 70 cents per ton--or approximately $12 to $15 annually per acre of beets--by making arrangements for the joint ownership of harvesting machinery.

It is estimated that the savings that would accrue from the joint ownership and operation of a beet harvester, as compared to the costs that would be incurred for custom harvesting, would be adequate to pay for a beet harvester in one season.

Table 3. Estimated cost of harvesting 700 acres of sugar beets with a 2-row harvester

Item	Total annual cost a/	Cost per ton a/
	Dols.	Cents
Beet harvester costs		
Depreciation b/	2,400	16.4
Repairs and maintenance b/	1,600	10.9
Oil and grease	40	0.3
Interest on investment c/	310	2.1
Taxes and insurance d/	80	0.6
Total	4,430	30.3
Tractor costs e/		
Depreciation f/	515	3.5
Repairs and maintenance g/	605	4.1
Fuel h/	590	4.0
Oil and grease i/	90	0.6
Interest on investment c/	310	2.1
Taxes and insurance d/	80	0.6
Total e/	2,190	14.9
Tractor driver j/	1,320	9.0
Management k/	1,500	10.3
Interest on operating capital l/	140	1.0
Grand total e/	9,580	65.5

a/Estimated costs are based on 14,630 gross tons per machine, which is the estimated production from 700 acres at 20 tons per acre plus 4.5% tare.

b/Depreciation on the harvester is based on 3 years life with 10% trade-in value on $8,000 new machine. Depreciation, repair and maintenance cost are based on data from Imperial Valley, California, farmers and dealers.

c/Interest is charged at 7% on the average inventory value during the life of machine (average inventory value, $4,400).

d/Taxes and insurance estimated at 1.8% of average inventory value.

e/The tractor costs shown here assume that the tractor is used only for harvesting sugar beets. To the extent that the tractor is used for other work, the cost of depreciation, taxes, insurance, and interest on the investment chargeable to sugar beet harvesting would be reduced.

f/Depreciation on tractor is based on a 14-year life for an $8,000 diesel wheel tractor, less 10% trade-in value.

g/Repairs and maintenance on tractor are estimated at 1.2% of purchase price of tractor per 100 hours of actual use. Tractor time is estimated at 0.9 hour per acre.

h/Diesel fuel requirements are estimated at 5.7 gallons per hour of tractor operation @ 16.5 cents per gallon. Tractor time is estimated at 0.9 hour per acre.

i/Cost of oil and grease estimated at 15% of cost of fuel.

j/Tractor driver, 88 days @ $15 per day.

k/Represents one-half time of a foreman @ $600 per month plus $150 per month for transportation and communication expenses.

l/Represents 7% interest for 4 months on $5,900 to cover cost of repairs, fuel, oil, grease, taxes, insurance, tractor driver, and management.

Before embarking on this venture, however, growers would need to have experience in the operation of a beet harvester or hire a well-qualified, experienced beet harvester operator to manage the enterprise. Two "harvest pools," for example, might jointly employ a full-time, experienced man during the beet harvest season to supervise the operations of both "pools."

Hauling Beets to the Factory

It is expected that hauling will be done largely by custom operators. Hauling charges are expected to be about the same as they are in the areas of California where the sugar company operates. This includes a charge of about 90 cents per ton for loading the beets in the field plus a charge of 3 cents per ton per mile for hauling, based on the one-way mileage from the field to the factory. Charges are based on the gross weight of beets hauled.